Silvicultural and Ecological Considerations Of Forest Biomass Harvesting in Massachusetts

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Silvicultural question:

1. **What is the potential quantity of biomass fuel that could be harvested from a typical sawtimber stand in Massachusetts?**

Methods:

- **Used 1998-2000 data from state CFI plots (for public lands) and USFS FIA plots (for private lands)**
- **Used USFS tree biomass equations to calculate total stand biomass**
- **Modeled crown thinning (50% biomass removal)**

Biomass of typical sawtimber stand in Massachusetts (age 70-100 years)

	dry tons/acre
Total tree biomass	70
Large high-quality trees	25
Large cull trees	22
Small trees	15
Harvest residues (slash)	9
Potential biomass harvest	45

Typical partial harvest (patch selection) in Massachusetts

Typical partial harvest in sawtimber stand in Massachusetts (age 70-100 years)

	dry tons/acre	MBF/acre
Large high-quality trees		3
Large cull trees	7	
Small trees	15	
Harvest residues (slash)	3	
Total biomass harvest	25	

Silvicultural question:

2. **At statewide level, what is the total annual sustainable biomass harvest (based on the total annual forest growth)?**

Methods:

- **Determined area of public and private forestland in state**
- **Reduced public land area based on reserves, and reduced private land based on landowner willingness to harvest**
- **Determined mean forest growth rate using growth model FVS-NE (also known as NE-TWIGS)**

Statewide land area and harvest level

Mean biomass growth rate	0.9 dry tons/acre/year
Land available for harvest	
public land	465,000 acres
private land ≥ 10 acres	1,070,000 acres
private land ≥ 100 acres	380,000 acres
Sustainable harvest level	
public + private ≥ 10 acres	890,000 dry tons/year
public + private ≥ 100acres	500,000 dry tons/year

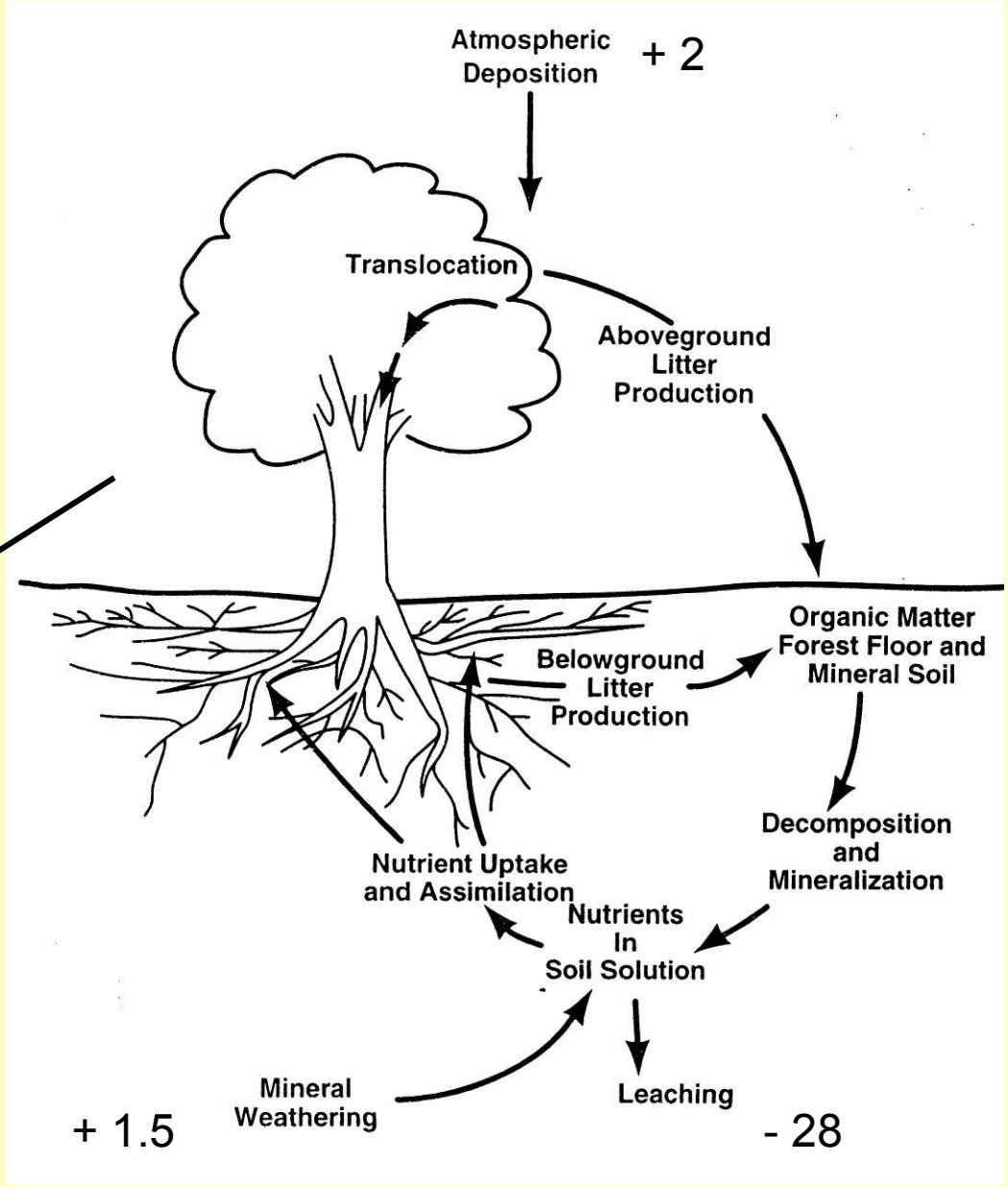
Ecological implications of increased harvesting intensity for biomass

- Nutrient cycling and retention
- Streamflow and water quality
- Maintenance of high carbon sequestration rate

Calcium loss from clearcut and thinning harvests

(units are kg/ha)

Clearcut harvest removal
- 530

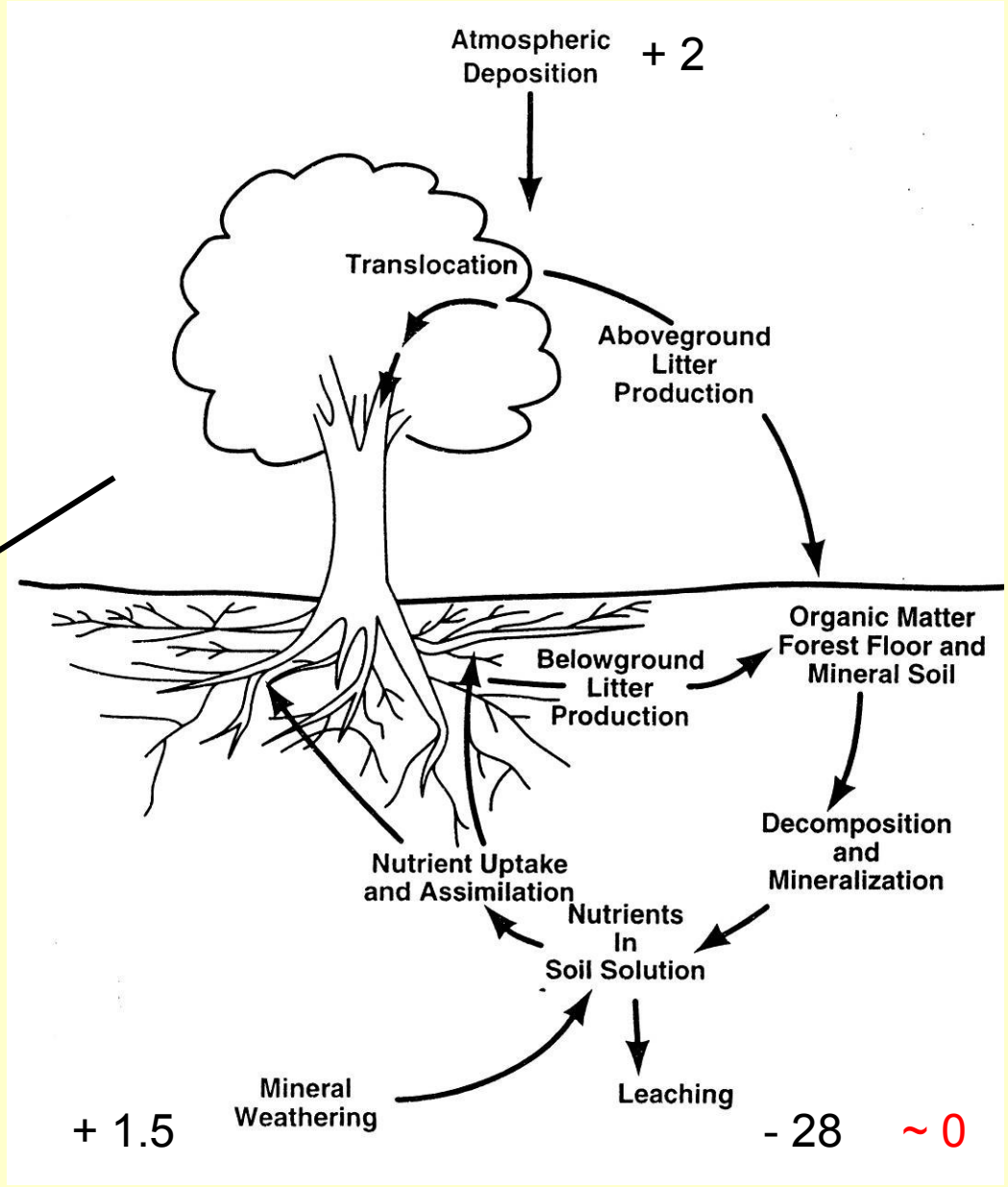


Calcium loss from clearcut and thinning harvests

(units are kg/ha)

Clearcut harvest removal
- 530

Thinning harvest removal
- 250

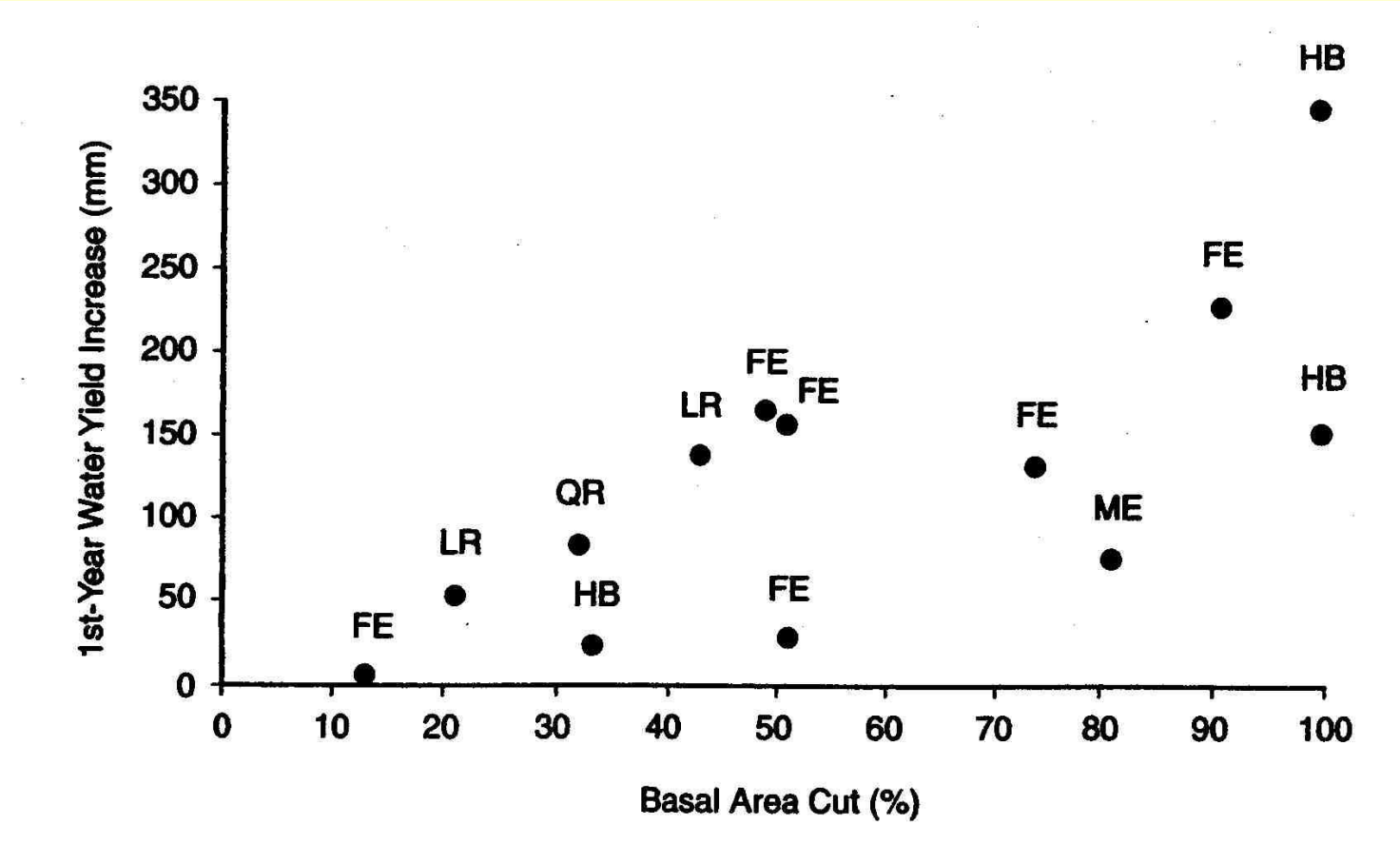


Recovery time for site to return to pre-harvest levels of calcium

Clearcut with biomass harvest:	**160 years**
Thinning with biomass harvest: (~ 50% removal)	**70 years**

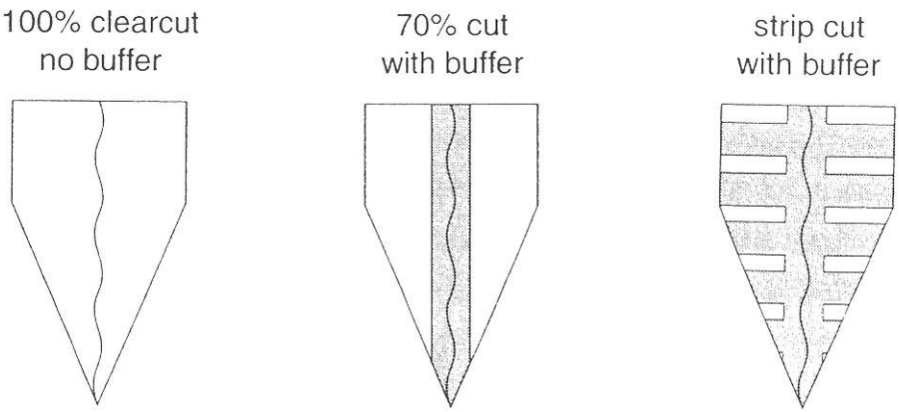
Consequences of heavy cutting on streamflow and water quality

- Increased movement of harvesting equipment may cause soil compaction, leading to overland flow of water
- Increased water flow may increase nutrient loss and sedimentation



Water yield (streamflow) increases in proportion to basal area cut in watershed

Nutrient losses in streamwater with three harvest methods

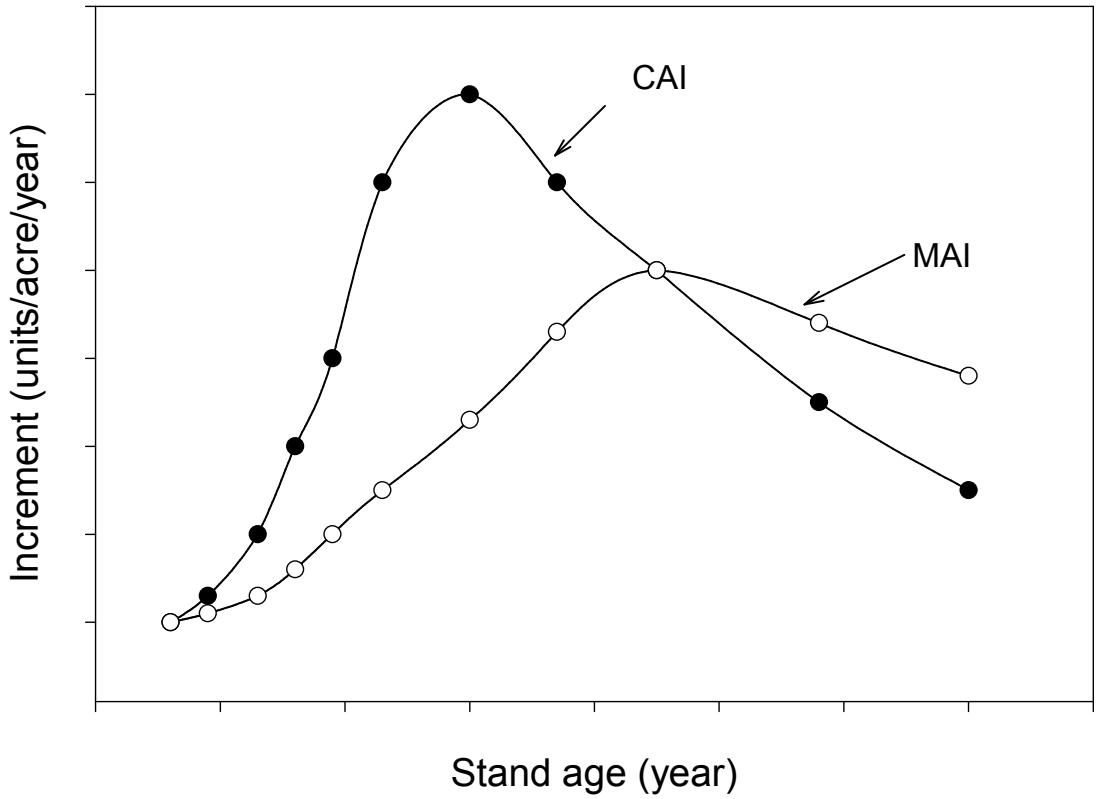


	100% clearcut no buffer	70% cut with buffer	strip cut with buffer
Nitrate:	18	9	4
Calcium:	4	3	2

(Units: mg/L)

Overland flow caused by soil compaction on skid trail

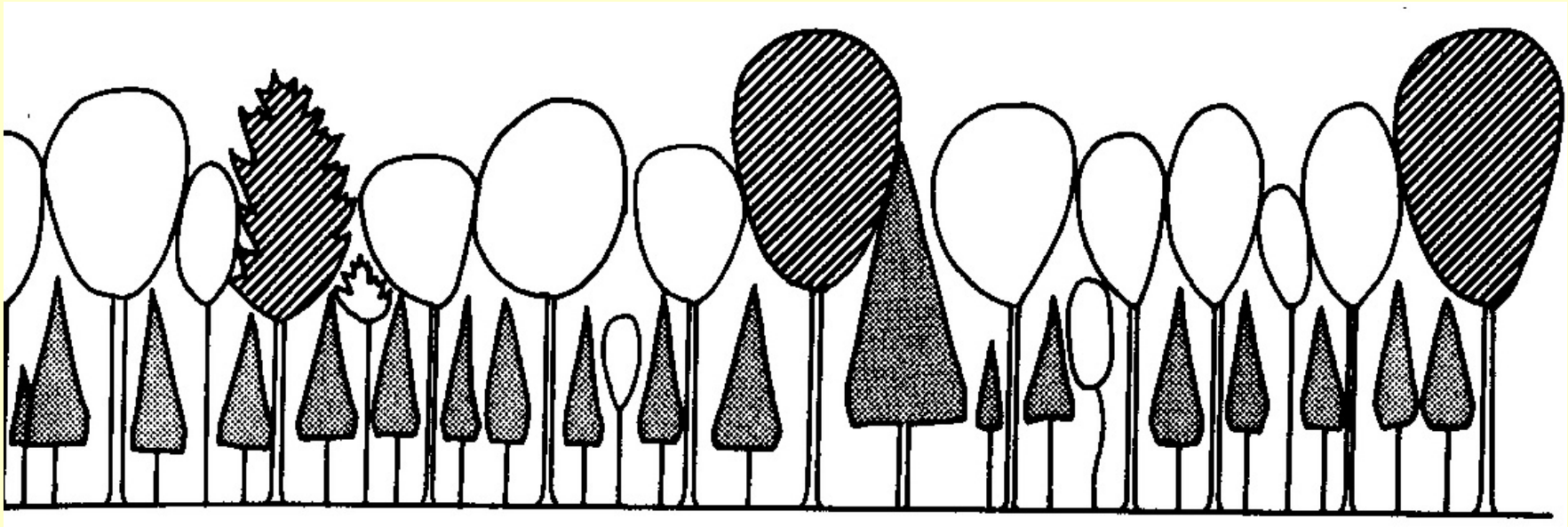
Carbon sequestration in forest stands



Current annual increment (biomass growth) of forest stand; peak of CAI occurs at time of canopy closure. Maximum biomass harvest occurs at peak of MAI.

Willow coppice system in Ireland.
CAI occurs at age 2 years; MAI at age 4 years.

Aspen stand being harvested at 20 years.



Stands with layered canopies are often the most productive:

- **the fast-growing upper layer creates a closed canopy quickly**
- **the slow-growing lower layer adds to the biomass production**

CONCLUSIONS

- **Whole-tree clearcutting should not be used because of depletion of site nutrients.**
- **A combination of use of partial harvesting and adherence to Best Management Practices will avoid water quality problems from nutrient loss and sedimentation.**
- **Establishing and maintaining mixed-species stands on appropriate sites will maintain high carbon storage rates.**
- **Intensive biomass cropping systems have been under research, and may be economically feasible in the future.**

- **Massachusetts forests can sustain an annual biomass harvest of 500,000 to 900,000 dry tons/year.**
- **A typical sawtimber stand can provide a biomass harvest of 25 dry tons/acre/year in a partial harvest that also removes sawlog trees for lumber or veneer.**
- **The harvest of trees that are small or poor quality will improve forest management (current and future values).**
- **Most Massachusetts forests are owned and managed for the environmental services they provide: provision of clean water, biodiversity conservation, open space, recreation, and (for private lands) privacy for the landowner's home. Biomass harvests must be designed to be economically viable, but also must leave post-harvest forest stands in a condition that still provides these ecosystem services.**